



Materials Engineering Branch

TIP*



No. 098 Lack of Weld Penetration in Propulsion System Components

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Weld metal that does not penetrate to the bottom of the weld joint or through the cylinder wall thickness results in lack of penetration¹ (LOP). LOP defects are caused by improper weld joint design or by incorrect welding technique. When LOP defects are not detected in valves, regulators, tanks, thrusters and other propulsion system components, prior to assembly, the defective components will be welded into the spacecraft propulsion system resulting in costly delays and possible safety hazards.

LOP defects in latch valve welds have been observed in fully integrated spacecraft. They have also been discovered in nitrogen thrusters after thruster acceptance testing was completed. Severe problems can result from LOP weld defects in a spacecraft propulsion system. X-ray radiographic testing and repair welding may expose spacecraft electronics in associated hardware to levels of electromagnetic radiation and/or weld currents that could cause failures of sensitive electrical components.

Another concern is the cost impact of having to verify a safe launch of components with LOP defects. When a spacecraft that contains LOP defects is launched, combined loads from propulsion system pressure, launch vibration loads and residual welding stresses can fracture the component. Likewise, if LOP defects exist in the propellant system, while in orbit, sustained residual welding tensile stress and propellant exposure can cause stress corrosion cracking and resultant propellant leakage.

In order to avoid LOP weld failures, all propulsion system weldments should be designed for complete weld metal penetration. Complete penetration should be verified by metallographic sectioning of sample welds coupled with either x-ray radiography or eddy current inspection.

¹ "Welding, Brazing and Soldering", Volume 6, Metals Handbook, Ninth Edition, American Society for Metals, Metals Park, Ohio, 1983.